Laboratory report

Central Application Laboratory
C.A.B. - Elcoma
Eindhoven - the Netherlands

Nederlandse Philips Bedrijven N.P.B. Eindhoven - Nederland

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Title : Example for the application of the TEA1060 speech circuit for the German market

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Author(s) : P. Sijbers

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author P.J.M. Sijbers

SUMMARY

The German Post Office nowadays requires a complex impedance for telephone sets.
In practice this requirement makes it necessary to rebalance the anti side tone circuit of the TEA1060.

This report gives an example how to rebalance the anti side tone circuit.
Furthermore an application proposal for the TEA1060 is presented, that fulfils the transmission requirements for: Reference equivalents (EBD, SBD, RBD), electrical frequency characteristics, noise, BRL and DC resistance.

P.J.M. Sijbers
Appr. v.d. Kam

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I. INTRODUCTION

Beginning 1984 the existing C.A.B. speech/pulse dialling p.c. board nr. 3132 was handed over to German setmakers in order to get feedback from the market. The p.c. board was not intended to present an optimum solution for the German market. A first impression of the performance of this p.c. board has been presented in Ref. 1.

Two problems were encountered:

- the anti side tone circuit of the TEA1060/1061 had to be investigated with complex line matching impedance.
- The DC requirement at 2mA line current was not fulfilled.

In the mean time the anti-side tone circuit of the TEA1060/1061 has been investigated with complex line matching impedance. The results are described in Ref. 2.

Two possibilities are given in Ref. 2 to rebalance the bridge. Furthermore it is shown that a changeover to the Wheatstone bridge structure is an alternative.

In order to give somewhat more application support, a proposal for the German market has been worked out, that fulfils the requirements for:

- "Rückflussdämpfung" (Balance Return Loss) with complex reference impedance
- the electrical frequency characteristics
- the side tone (RBD)
- the send and receive reference equivalents (SRE, RRE)
- noise
- DC resistance of the set.

II. SOME CONSIDERATIONS

The frequency characteristic of the sending channel loaded with 600 Ω at the a/b terminals must be nearly flat.

The set impedance must be complex in order to meet the BRL requirement.

Because these two requirements are contradictory a compromise has been chosen between BRL and the electrical frequency characteristic by choosing a set impedance of 825Ω//33nF.

In Appendix I it is shown how to rebalance the anti side tone circuit with this set impedance assuming that a line length of 5km 0,5mm diameter copper twisted pair must give optimum side tone performance.

The circuit diagram is given in Fig. 1.
Note that the dialling part is not designed especially for Germany.

Some tests have been done on the circuit according to the FTZ requirements described in "Übertragungstechnische Bedingungen für Fernsprechapparate FTZ 121R8 (March 1983)"
The latest FTZ ideas about "Schnittstellen" between the transducers and the speech circuit have been taken into account.

III RESULTS OF MEASUREMENTS

The number of the following items correspond with the numbers used in FTZ paper: FTZ121R8 (March 1983).

3. "Bezugsdämpfungen"
The "Sendebezugsdämpfung (SBD)"; the "Empfangsbezugsdämpfung (EBD)" and the "Rückhörbezugsdämpfung (RBD)" have been measured on the OBDM measurement set up.
Standard Piezo transducers have been used.

Results:

	Measured (dB)	Requirement (dB)
SBD	+0.4	0
EBD	-5.6	-6
1)RBD	14.3	≥10

1) Weighted total mean value (35 connections)
Not corrected for Δ SBD and ΔEBD
Table I shows the results for all 35 connections

6. FREQUENCY CHARACTERISTICS OF THE AMPLIFIERS

6.1 Frequency characteristic sending

Fig. 2 shows the electrical frequency characteristic measured between microphone inputs and the a/b terminals with 600 Ω load.

$$\begin{array}{l} Am = 43.6dB \text{ at } 300Hz \\ \left.\begin{array}{l} Am = 43.7dB \text{ at } 1kHz \\ Am = 43.3dB \text{ at } 3.4kHz \end{array}\right\} \Delta = -0.4dB \end{array}$$

6.3 Frequency characteristic receiving

Fig. 3. shows the electrical frequency characteristic measured between the a/b terminals and the receiver output (loaded with 200Ω asymmetrically)

$$\begin{array}{l} A_{TA} = -2.2dB \text{ at } 300 \text{ Hz} \\ \left.\begin{array}{l} A_{TA} = -2.2dB \text{ at } 1 \text{ kHz} \\ A_{TA} = -1.6dB \text{ at } 3.4 \text{ kHz} \end{array}\right\} \Delta = -0.6dB \end{array}$$

Note that the complex set impedance causes some extra frequency dependency (≃ 0.4dB from 300Hz to 3.4Hz if it is measured with a sine wave generator with 600Ω source impedance connected to the a/b terminals.

9. "Geräuschspannung"

The noise has been measured psophometrically weighted in accordance with CCITT recommendation P53.

I_{line} = 25mA (corresponding with R_V = 1200Ω)

	noise voltage (μV)	
	measured	Requirement
- a/b line with 600 Ω load	78	≤ 200
- earpiece output with 200Ω load	70	≤ 100

15. "Rückflussdämpfung" (Balance Return Loss)

The balance return loss measured against the required complex reference impedance (220Ω + 820Ω//115nF) is shown in Fig. 4.

The FTZ requirement is met.

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19. "Gleichstrombedingungen"
Measured results

	Line resistance $R_V(\Omega)$	Requirement $R_{app}(\Omega)$	Measured		
			$I_{line}(mA)$	$V_{line}(V)$	$R_{app}(\Omega)$
Speech condition	$\leq$ 1530	$\leq$ 470	$\geq$20		$\leq$320
	1530	$\leq$ 470	20	6,39	320
	27k7	$\leq$ 2k25	2	3,96	1k98
	218k	$\leq$ 22k	0,25	3,15	12k6
Mute condition	$\leq$ 1530	$\leq$ 325	$\geq$ 20		$\leq$ 320

The 2k resistor between pins 1 and 18 of the TEA1060 reduces the voltage drop across the speech circuit at 2mA line current in such a way that the 2k25 requirement can be met.
Requirement for the mosfet used as an interrupter is that: $R_{dson} \leq 250\Omega$ at $V_{gs} = 2.0V$.

The requirement in mute condition is just fulfilled. In order to get somewhat more margin, the voltage drop across the speech circuit can be decreased somewhat by means of a resistor between pins 1 and 16 of the TEA1060. (For details please see Ref. 3).

IV CONCLUSIONS

- FTZ requirements for "Bezugsdämpfungen", electrical frequency characteristics, noise, balance return loss and DC resistance are met.
- An example how to calculate the anti side tone circuit is given assuming that the side tone must be optimized for a certain line impedance (in this case 5km Ø 0,5mm matched with 600Ω).
  However in practice the German telephone lines have different diameters (0.4mm and 0.6mm) and they are matched with several impedances. Therefore it is more practical to optimize the side tone empirically (on the OBDM test set up) by juggling components (Z_{bal} and/or R_8). In this way a compromise for all 35 lines can be obtained.

V REFERENCES

1. P.J.M. Sijbers, Some considerations and measurements for the German market on the existing C.A.B. speech/pulse dialling combination. C.A.B. report nr. TTE84107.

2. P.J.M. Sijbers, Description of the anti side tone circuit of the telephone transmission circuits TEA1060/1061. C.A.B. report nr. TTE 84119.

3. P.J.M. Sijbers, Application of the versatile transmission circuits TEA1060 and TEA1061 in full electronic telephone sets. ETT8302.

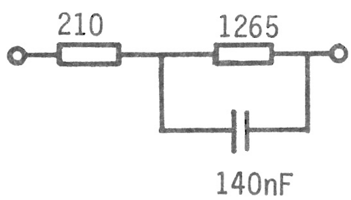
APPENDIX I

Rebalancing the anti side tone circuit of the TEA1060 with complex set impedance.

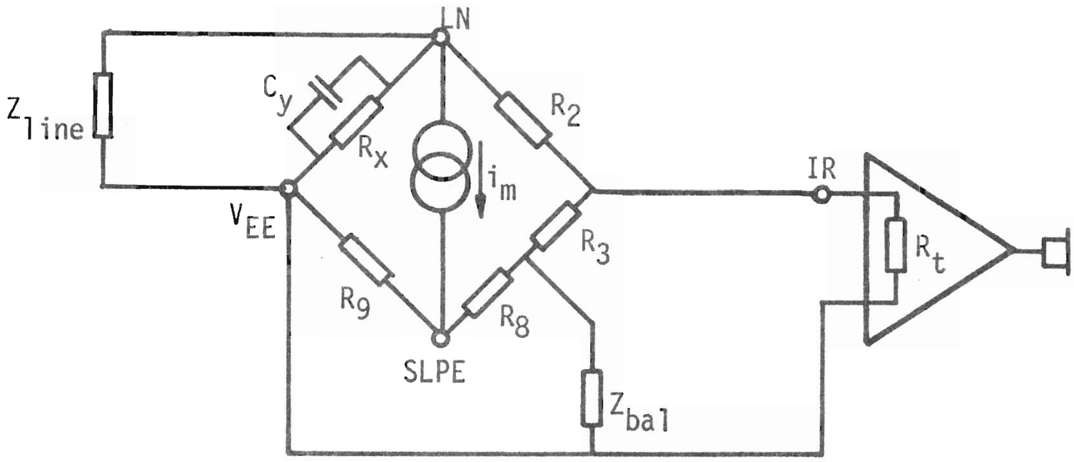
Starting points:
- a complex set impedance has been chosen 825Ω//33nF
- optimum side tone suppression must be obtained for a line length of 5km 0,5mm diameter copper twisted pair (176Ω/km, 38nF/km) matched with 600Ω.

  The corresponding line impedance can be approximated by

Z_{line}:



Equivalent circuit for the bridge: (Ref. 2)

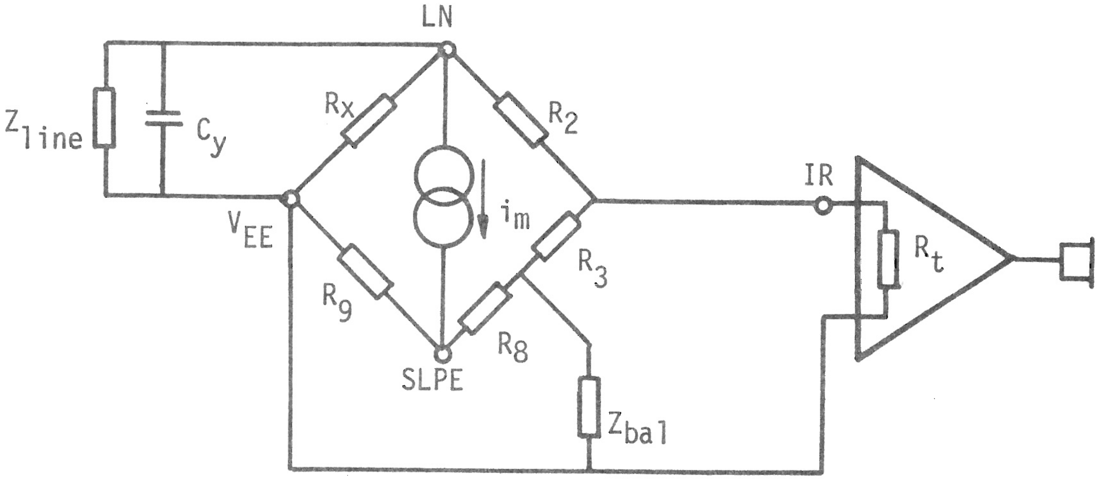


Original component values with R_X = 620Ω and CY=0 and Z_{bal} optimized for the same Z_{line} as given above:

R_2 = 130k R_3 = 3k92 R_9 = 20Ω R_8 = 390Ω

Z_{bal}: 130Ω + 820Ω//220nF

Rearranging C_Y shows that C_Y can be considered as a part of the line impedance:



From Ref. 2. we know that the bridge is balanced when

a. $R_9R_2 = R_X\ (R_3 + (R_8//Z_{bal}))$

b. $Z_{bal} = \frac{R_8}{R_X}\ (Z_{line}//\ Z_Y) = k\ (Z_{line}//Z_Y)$

in this case $Z_Y = \frac{1}{jwC_Y}$

Because R_X has a larger value (825Ω) than the original 620Ω (R_1) this means that the bridge can be rebalanced by increasing R_2 or by increasing R_9.
Because Piezo earpieces(which are insensitive) are used in Germany, a large receiving gain will be necessary.
Therefore the bridge attenuation should not be increased by increasing R_2. The alternative (increasing R9) has been chosen.

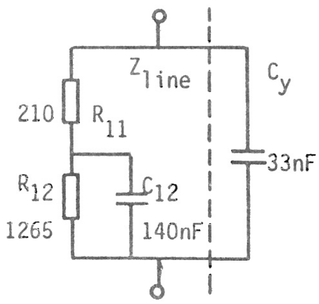
R_9 originally had a value of 20Ω.
The new value for R_9 (R_9') can be calculated very simple:

$$R_9' = \frac{R_X}{R_1} R_9 = \frac{825}{620} \cdot 20 = 26{,}6\Omega \text{ (standard value } 27\Omega)$$

Calculating Z_{bal} and R_8

Z_{bal} must be chosen in accordance with the line impedance in parallel with C_Y.

$Z_{line}//Z_Y$:

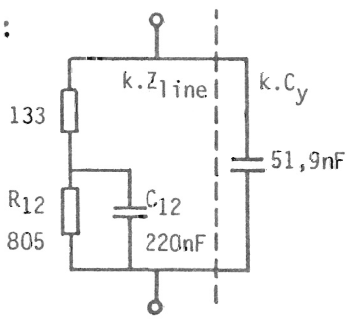


In order to obtain a standard value for the capacitor in Z_{line} and to fulfil condition a), scale factor k has been chosen $k = \frac{140nF}{220nF} = 0{,}64$.

This results in:

$R_8 = k\, R_X = 0{,}64 \cdot 825 = 525\Omega$

Z_{bal}:



Taking standard values for components; the final result is: $R_8 = 510\Omega$ $R_{11} = 130\Omega$ $R_{12} = 820\Omega$
$C_{12} = 220nF$ $kC_Y = 56nF$

In this case Z_{bal} cannot be simplified, which means that one extra capacitor is needed in Z_{bal} to compensate for the influence of C_Y.

Table I Reference Equivalents
measured with C_m = 33nF
transducers: Siemens S8 and H8 in handset "71"

Meßverbindung	Gruppennummer	Gewichtung n	Meßwert [dB] $\frac{\text{Max + Min}}{2}$	$\sum$ Meßwert [dB] Gruppe	$\bar{X}$ Meßwert [dB] $\frac{\text{Gruppe}}{5}$	$\bar{X}$ Meßwert [dB] gewichtet $\frac{\text{Gruppe}}{5} \cdot n$
1 2 3 4 5	1	1	10,9 11,3 12,1 9,8 21	65,1	13,02	13,02
6 7 8 9 10	2	5	8,5 10 10 8,3 17,3	54,1	10,82	54,1
11 12 13 14 15	3	8	13,4 12,7 15,6 11,4 24,5	77,6	15,52	124,16
16 17 18 19 20	4	2	17,3 14,6 21 14,3 20,1	87,3	17,46	34,92
21 22 23 24 25	5	1	17,7 15,6 19,3 15,9 17,3	85,8	17,16	17,16
26 27 28 29 30	6	2	15,9 10,5 12,6 13 18,3	70,3	14,06	28,12
31 32 33 34 35	7	2	16,4 12,4 15 13,6 13,4	70,8	14,16	28,32

$\sum \bar{X}$ Meßwert gewichtet
299,8 dB

$\frac{\sum \bar{X}\text{ Meßwert}}{21}$ (RBD)
14,27 dB

SBD
+ 0,4 dB

EBD
− 5,6 dB

Note: Asymmetrical earpiece connection is assumed. Symmetrical earpiece connection is also possible. In that case the corresponding value for R_4 = 143k.

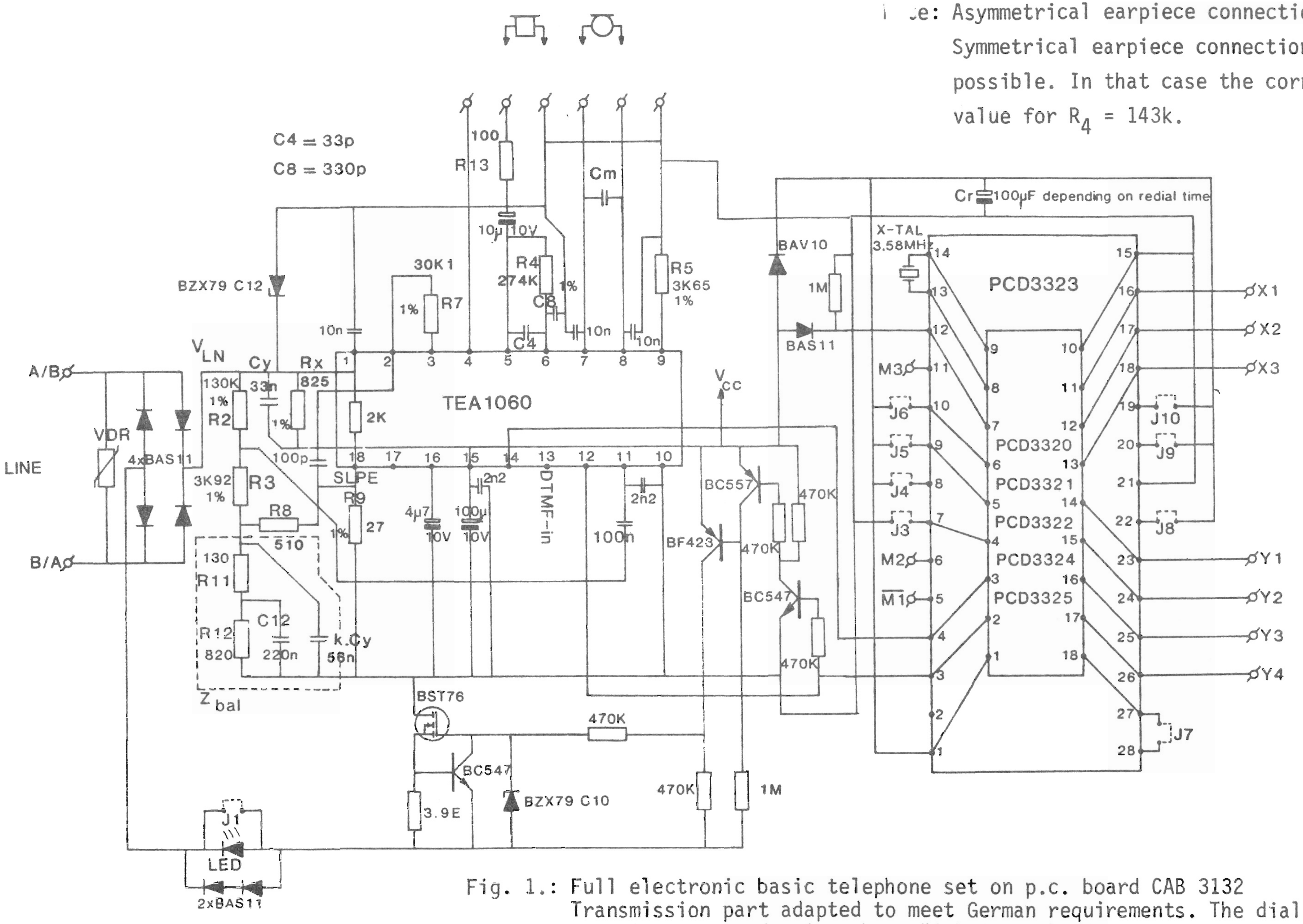


Fig. 1.: Full electronic basic telephone set on p.c. board CAB 3132
Transmission part adapted to meet German requirements. The dialling part is unchanged. Microphone "Schnittstelle":

FTZ requirement Z_{in} = 8k2//47nF.
Input impedance of TEA1060 (pins 7 and 8) is typical 8k6
(upper and lower limits are 10k2 and 7k2)
C_m = 47nF - (Cpin7 + Cpin8)/2 = 42nF

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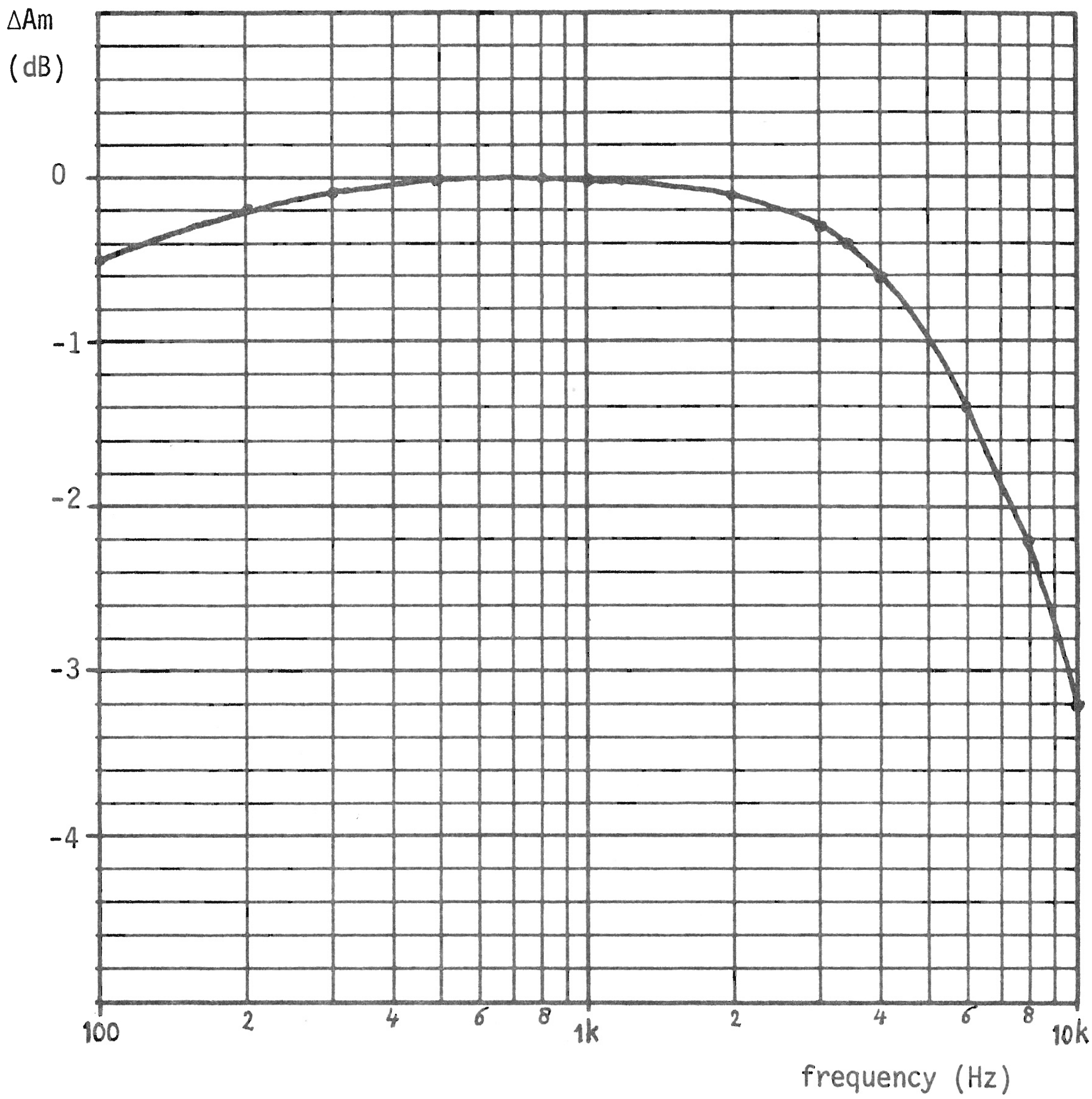

Fig. 2 Electrical frequency characteristic sending
0dB = 43,7dB gain
600Ω load at a/b

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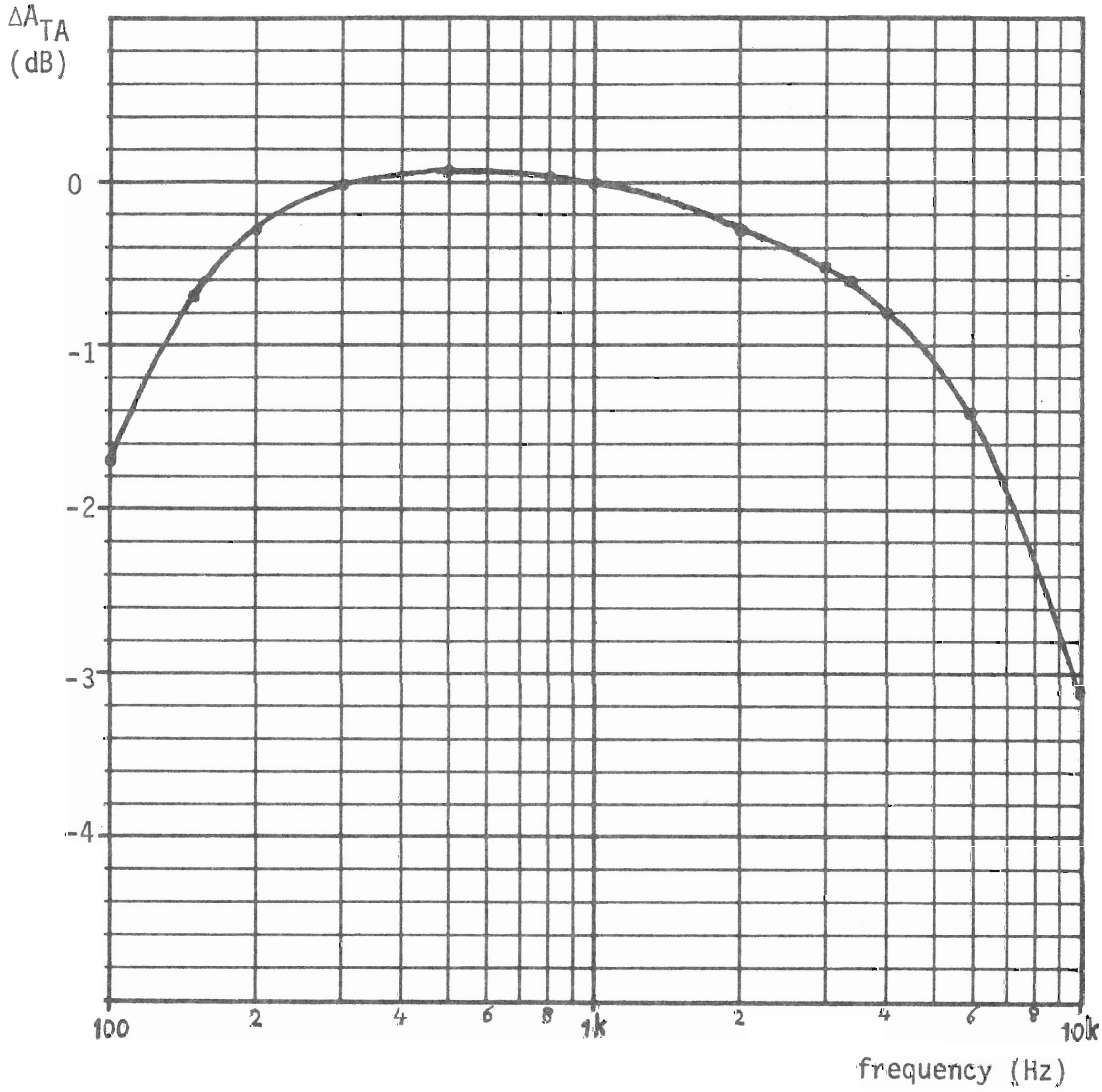

Fig. 3: Electrical frequency characteristic receiving
0dB = -2,2dB gain
200Ω load at receiver output.
Measured from a/b to receiver output.

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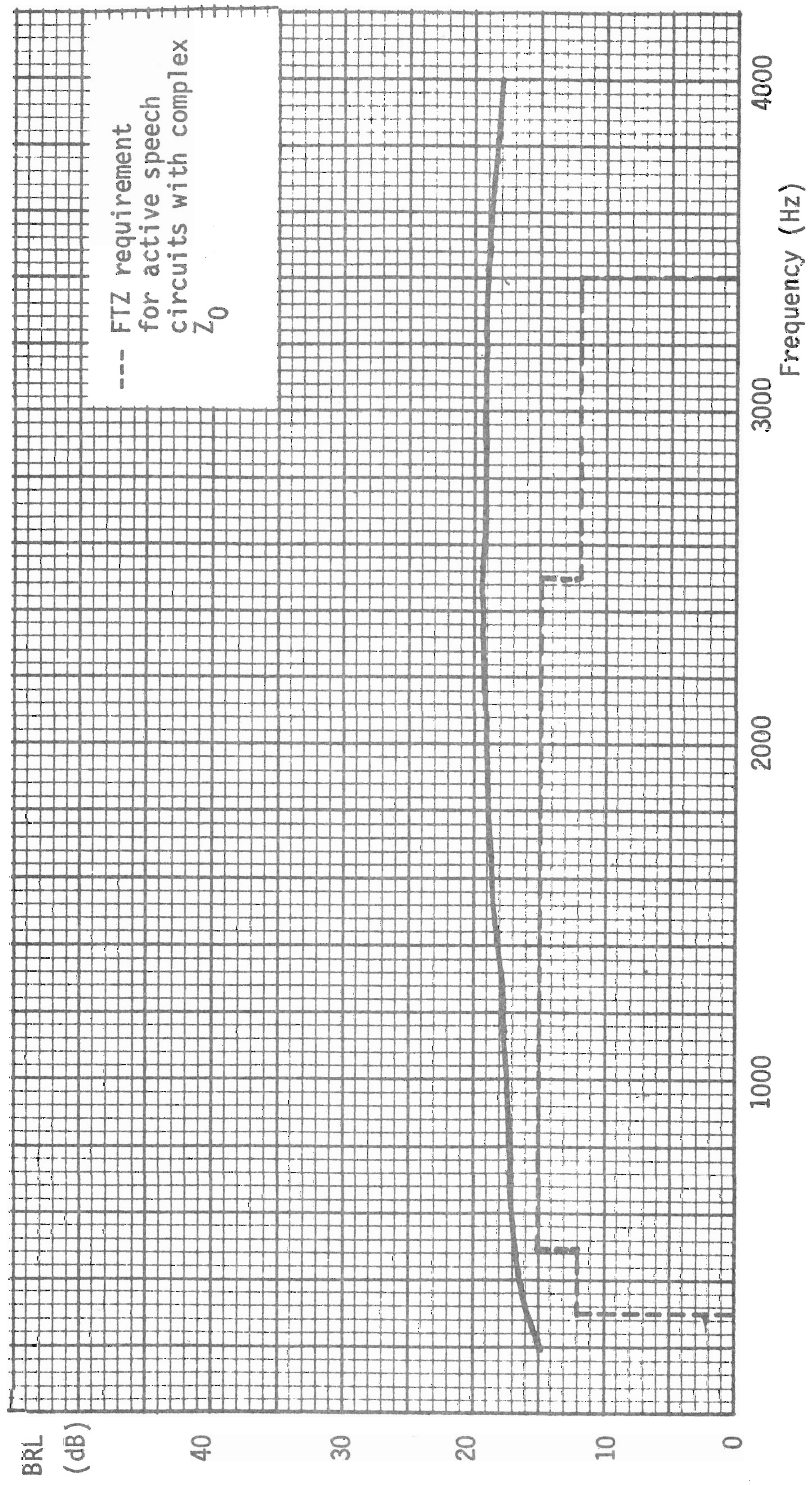

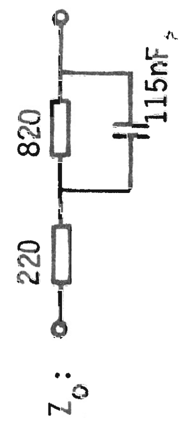

Fig. 4. Balance Return Loss $= 20 \log \left| \frac{Z + Z_o}{Z - Z_o} \right|$

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